

The NOAA ESRL Global Systems Laboratory (GSL) developed the hourly High-Resolution Rapid Refresh (HRRR) weather prediction model using the latest observations from a network of ground, aircraft, and satellite-based sensors, to produce forecasts of high-impact weather on a neighborhood scale.

### High-Resolution Rapid Refresh (HRRR)

The first version of the HRRR weather prediction model went into operations at the NOAA National Weather Service (NWS) in 2014 to serve users needing frequently-updated short-range weather forecasts. The HRRR predicts weather parameters such as:

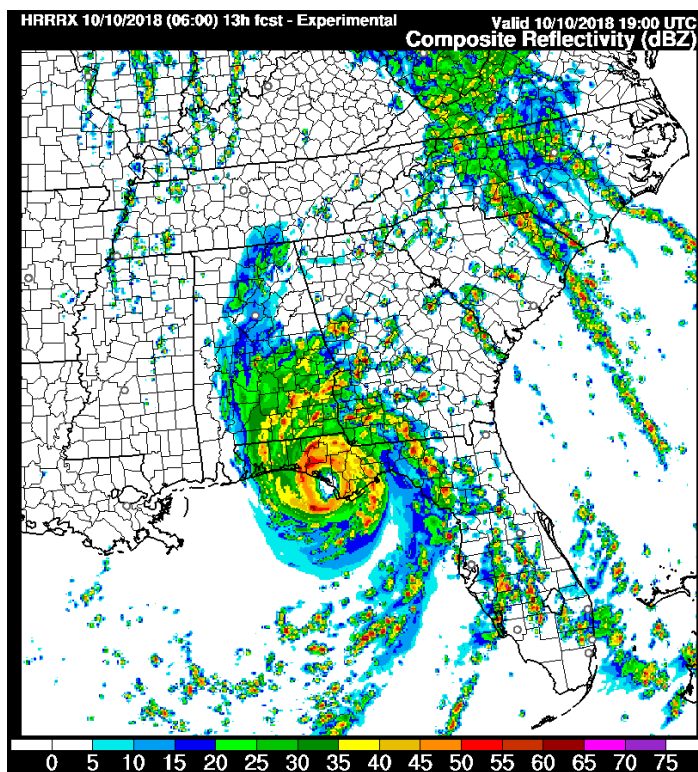
- Potential severe weather hazards including tornadoes, high winds, flooding, and blizzards that threaten public safety
- Visibility and cloud ceilings to reduce air traffic delays that cost the airline industry billions of dollars each year
- Wildfire smoke plumes to support air quality and visibility advisories.

### Research to operations

An experimental version of HRRR (HRRRX) always runs at GSL as a real-time demonstration of advances before those changes are implemented into the NOAA operational HRRR model. Code for the next and final upgrade of the HRRR (version 4) has been delivered to NOAA's Environmental Modeling Center for nine months of testing before being implemented into operations in 2020. This version includes an enhanced physics suite that improves how the model depicts clouds smaller than 3km and their effect on the local environment, and how terrain impacts horizontal flow.

### HRRR for renewable energy

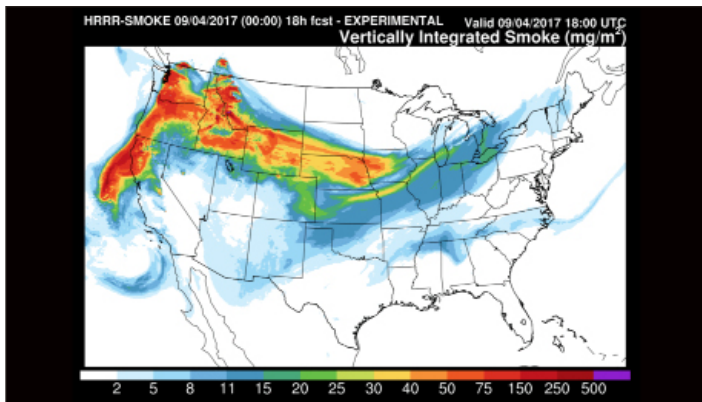
The HRRR model is used as input to the private sector's tailored forecasts to optimize the mix of energy generation sources, balance power supply and demand, and maintain grid reliability. New research on wind behavior in complex terrain led by NOAA and the U.S. Department of Energy will improve HRRR forecasts for wind energy firms by 15-25 percent, and improve wind forecasts for the entire country.



The experimental HRRR predicted the landfall of Hurricane Michael within 5 miles and 30 minutes - 13 hours in advance. It also correctly forecasted supercell thunderstorms over Georgia.



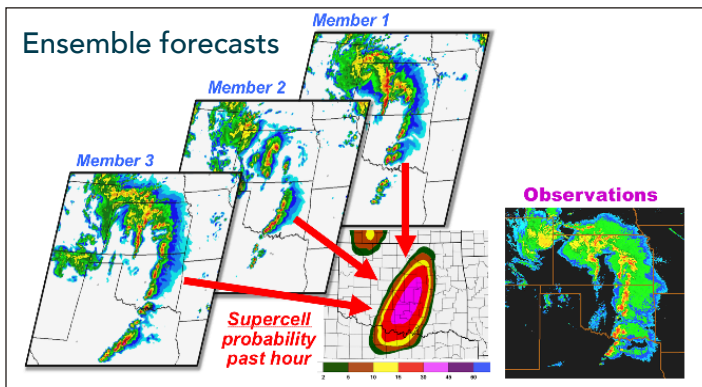
A wind farm near Tehachapi, CA. Credit: NOAA Will Von Dauster



GSL's experimental HRRR-SMOKE model prediction of smoke transport is often used for air quality forecasts.

### HRRR-SMOKE

Smoke aerosols have the greatest potential to impact meteorology during wildfire season. HRRR-SMOKE predicts the transport of smoke plumes and the impact on visibility and temperatures. HRRR-SMOKE is the first experimental numerical weather prediction model in the U.S. that predicts smoke impact on surface visibility and will be implemented into operations in 2020.



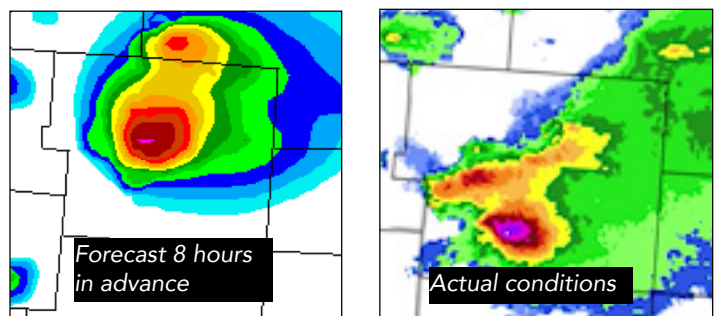
An example of how a range of solutions can converge on the most likely hazardous weather situation.

### HRRR-Ensemble (HRRRE)

Challenging forecasts have uncertainty, and ensembles provide information about a range of possible outcomes and the probabilities they will occur. The HRRRE is an ensemble that provides forecasts for weather phenomena such as severe thunderstorms. This provides more information to decision-makers about the scenarios most likely to occur which will help them mitigate risk. HRRRE predictions launch the NOAA National Severe Storms Laboratory's experimental Warn-on-Forecast System, which includes sub-hourly radar and satellite data assimilation for short-term (0–3 hour) ensemble forecasts.

### The future of HRRR: Rapid Refresh Forecast System

GSL is a key partner in building the foundation for future state-of-the-art extended global forecasts. The future of systems like the HRRR will be to provide real-time ensemble analyses and forecasts with improved skill and uncertainty information. To this end, development of an ensemble assimilation and prediction system known as the Rapid Refresh Forecast System (RRFS) using NOAA's new dynamical core is geared for transition to operations 2022.



The HRRR model produced a prediction of severe weather to the correct county 8 hours in advance, including a forecast of massive hail that hit parts of the Colorado Springs, CO area in August 2018. The damage shown above was caused by baseball-sized hail.

### For more information:

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